

[0043] The drive arm 316 extends along and is coaxial with the principal axis of the engine and is generally axi-symmetric. The drive arm 316 includes a coupling 348 and a carrier shaft which comprises a fore drive arm 344, the carrier 328 and an aft drive arm 346. It will be appreciated that the so-called aft drive arm does not carry any driving torque and is thus functionally a support shaft rather than a drive shaft per se.

[0044] The coupling 348 extends from a first end, which is attached to the main body of the fan shaft, to the fore drive arm 344. The attachment of the coupling to the fan shaft is dependent on many factors but will generally be placed at the point which minimises the radial deflections of the fan shaft which are transmitted to the gearbox. The coupling 348 helps isolate the gearbox from vibration and bending moments experienced by the fan when in use. Thus, the coupling is torsionally rigid but relatively flexible in the radial direction.

[0045] The fore 344 and aft 346 drive arms provide a single rotating structure with the carrier 328 to provide the carrier shaft. The carrier shaft is held in rotative alignment with the principle axis of the engine via the gearbox housing bearings 340, 342. It will be appreciated that other configurations of bearings may be used. For example, the bearings need not be attached to the housing of the gear box structure.

[0046] The fan 350 is mounted to the hub portion of the shafting arrangement. The hub portion 320 includes a radially outer body shaped to receive the root end of the fan blades 352 in a conventional manner. The hub portion 320 is mounted to the fan shaft 312 so as to be rotatably locked and so co-driven therewith about the principal axis of the engine.

[0047] The front bearing portion 354 is in the form of a small stub shaft which is concentrically nested around a shaft of the hub portion 320 and the fan shaft 312 and provides the inner bearing race. The front bearing portion 354 provides a platform for receiving the inner race of the front bearing. The platform is in the form of a cylindrical wall which is spaced from and radially outside of the outer surface of the fan shaft 312.

[0048] The inner race of the front bearing 356 is mounted to the outer surface of the front bearing stub shaft towards a distal end thereof. The radially outer race of the front bearing 356 is supported by a frustoconical support wall 322 which extends radially outwards and downstream from the bearing race and attaches to the engine casing local to the compressor inlet and first guide vane. Thus, the front bearing 356 provides radial support for the fan 350 and fan shaft 312 and reacts the load through the frustoconical wall 322.

[0049] In the described embodiment, the front bearing 356 is a roller bearing having an inner race, an outer race, a plurality of roller elements circumferentially distributed around the stub shaft and retained within a cage, as is known in the art. It will be appreciated that although a roller bearing is described in connection with the arrangement shown in FIG. 3, other bearing types may be used. For example, the front bearing may be a thrust bearing as shown in later Figures. The thrust bearing may be a ball bearing or taper bearing as are known in the art.

[0050] In order to provide sufficient structural rigidity to the fan shaft and to allow it to react off-centre loading of the fan 352, the fan shaft 318 requires two axially separated bearing locations. The axially separated bearings allow bending moments in the fan shaft 312 to be safely reacted to

the engine casing 338. In general, it is preferable from a structural loading point of view to place the bearings at certain minimal axial spacings which are dependent on the architecture of the engine and expected loads. Generally, the closer the bearings are, the larger the radial forces are on the bearings and structural supports. Providing a front bearing support upstream of the gearbox and one downstream of the gearbox generally provides for a suitable axial spacing and preferable structural arrangement. Another option would be to place two bearings upstream of the gearbox, however, to provide sufficient spacing the fan would need to be placed further forward which introduces numerous deleterious effects on the engine structural system.

[0051] In order to provide fore and aft bearings, the fan shafting arrangement includes a support shaft which passes through the centre of the gearbox. In the example shown, the support shaft 318 forms part of the fan shaft 312 and lies along the principle axis of the engine. The support shaft 318 passes freely through the sun gear 324 so as to have no direct contact therewith and so can be independently rotated and radially displaced relative to the sun gear and gearbox. Providing the support shaft through the sun gear and in structural isolation from the gearbox allows the radial loading and excursions on the fan shaft 312 to be taken out of the gearbox, vastly simplifying the mechanical requirements of the gearbox.

[0052] A first end of the support shaft 318 is located fore of the gearbox and is attached to a downstream end of the fan shaft 312, aft of the radially extending drive arm 316. A second end of the support shaft 318 is located on the downstream side of the gear train and terminates in the aft bearing which in the described example is an intershaft bearing arrangement 360. The intershaft bearing arrangement 360 resides between and allows relative rotation of the low pressure shaft 358 and the support shaft 318 whilst providing radial and axial restraint. The intershaft bearing arrangement includes an inner race, an outer race and a plurality of rolling elements in the form of ball bearings. Hence, the intershaft bearing is a thrust bearing and provides axial restraint of the fan shafting arrangement.

[0053] The intershaft bearing end of the support shaft is flared so as to provide a portion of wider diameter in the proximity of the bearing. The internal diameter of the flared portion is sufficient to receive the bearing and the opposing end of the low pressure shaft such that the bearing arrangement 360 is sandwiched therebetween with the support shaft 318 being on the radial outer thereof. Thus, the inner race is attached to the low pressure shaft 358, and the outer race is attached to the support shaft 318. The portion of the low pressure shaft 358 which supports the support shaft 318 terminates with the intershaft bearing. Hence, the low pressure shaft does not proceed axially within or through the support shaft fore of the intershaft bearing.

[0054] The low pressure shaft 358 lies along the principal axis of the engine and provides the driving connection between the low pressure compressor and low pressure turbine. The low pressure shaft 358 is radially and axially supported by appropriate bearings along the length thereof. As can be seen in FIG. 3, one of these bearings is a thrust bearing 362 located towards the fore end of the shaft. The thrust bearing 362 provides radial and axial retention of the low pressure shaft 358 and also provides a stable location for the intershaft bearing 360 which is fore of the low pressure shaft bearing. The main thrust bearing 362 of the low